ESD Starts Where STEM Stops: Integrating the Social Sciences into STEM

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Abstract: *The Earth and its peoples are facing great challenges. As a species, humans are over-consuming the Earth's resources and compromising the capacity of both natural and social systems to function in healthy and sustainable ways. Education at all levels and in all contexts, has a key role in helping societies move to more sustainable ways of living. Two areas in need of catch-up in relation to Education for Sustainable Development (ESD) are early childhood education and teacher education. Another area of challenge for ESD is the way it is currently oriented. To date, a great deal of emphasis has been placed on scientific and technological solutions to sustainability issues. This has led to an emphasis on STEM education as education's main way of addressing sustainability. However, in this paper it is argued that sustainably is primarily a social issue that requires interdisciplinary education approaches. STEM approaches to ESD - emphasising knowledge construction and problem-solving - cannot, on their own, deal effectively with attitudes, values and actions towards more sustainable ways of living. In China and Australia, there are already policies, frameworks, guidelines and initiatives, such as Green Schools and Sustainable Schools that support such forms of ESD. STEM educators need to reach out to social scientists and social educators in order to more fully engage with activist and collaborative educational responses that equip learners with the knowledge, dispositions and capacities to 'make a difference'.*

Keywords: education for sustainable development, STEM education, transformative education, green education, teacher education

1. Introduction: Creating a Common Future

It is widely recognised that the Earth‘s "natural capital" - the nature‘s ability to provide essential ecosystem services to support secure food production, maintain water quality, supply energy needs, moderate environmental impacts, and ensure social harmony and equity – is seriously compromised (Gough, 2005; Rees, 1996). In other words, current rates of resource consumption by the global human population are unsustainable (Kitzes, Peller, Goldfinger & Wackernagel, 2007) for human and non-human species, and for future generations. Further, these demands are compounded by continuing growth in world population and global political commitment to growth economics. Despite recognition of the serious consequences for people and planet, little consideration is given within most nations to the social and environmental issues that economic growth brings.

Australia, for example, is recognised as one of the developed countries most vulnerable to the impacts

of climate change. Yet, responses to date (including a highly-disputed and unpopular carbon-pricing levy that lacks political or community bi-partisan support) continue to be small-scale and fragmented, even though recent analysis of environmental threats to children's health in the Australian setting identified the following potential climate change impacts:

- changing patterns of infectious and vector-borne diseases such as dengue fever
- heat stress and health effects of extreme weather events such as fires, floods and cyclones
- effects of changing plant growth on allergen levels and asthma
- water and food insecurity
- pressure on mental and emotional health due to drought, climate change concerns, and traumatic exposures to fires, floods, and storms (Cooke, Davis, Blashki & Best, 2010).

For China, its tremendous economic growth and rapid urbanisation, has on the one hand, alleviated a great deal of human misery and poverty, but on the other hand, has had dire environmental and social consequences. These include exacerbation of flooding, water shortages and water pollution in major water basins, increasing desertification, extensive air pollution, loss of farming lands through urban sprawl, and destruction of landscapes (Guo & Marinova, 2011; Lam, 2008). China, as the first developing nation to announce a national plan to address climate change, also plans to become a leading county in developing a low-carbon economy. Nevertheless, China has a long way to go and is starting from a low baseline as, like Australia, its economy is heavily coal-reliant.

In summary, our current economic growth model is unsustainable where damaging exploitation of the natural world and exploitation of human beings are closely interwoven. With continuing environmental degradation and future disasters seemingly inevitable, a billion people living in poverty, and new waves of environmental refugees having the potential to undo 20 years of poverty reduction around the world, the world is confronting significant, complex and interlinked development and lifestyle challenges. Integrated approaches to development are required that examine the nexus of social, environmental and economic dimensions of human activity, that contribute to life improvements for all, and that do not diminish options for future generations. Regardless of the interests and concerns of individuals, nations and regions, the only common future is a sustainable future (Lowe, 2012).

2. The role of education.

Education across the lifespan is recognised as a crucial investment for sustainable development, with a key role in guiding the changes required to reduce consumption to sustainable levels and in empowering people for change (UNESCO, 2009). Rickinson, Lundholm & Hopwood (2009) comment that a life-course perspective on education and learning is needed "to think about what we know and what we need to know about environmental learning during infancy, childhood, adolescence, adulthood, middle age, retirement and old age" (p. 106). Thus, all education institutions – from early childhood centres, schools, community education, through to colleges and universities – need to provide effective ways to publicise and educate

communities with concepts of sustainability and environmental responsibility, through student learning and via their larger societal connections (Chesterman, 2008).

However, a different form of education is necessary from mainstream education which many see as being part of the sustainability problem (Orr, 1992), that is, education that supports economic growth, individualism and rising consumerism, and gives lesser attention to social and environmental justice. The call here is for mass education for sustainable development (ESD). ESD is not a new form of education. Its precursor, environmental education, has a 40 year history, with the Tbilisi Declaration (UNESCO/UNEP, 1977) stating that "environmentally-educated teachers are the priority of priorities". The Tbilisi Declaration noted that environmental education was life-long, interdisciplinary, holistic, focused on interrelationships and interconnectedness between humans and natural systems, and directed towards construction of an environmental ethic (McBeath & McBeath, 2009). The need for such an education has not diminished; indeed it has become more urgent.

3. STEM and Sustainable Development.

Currently, significant investments are being made into STEM as a key way for creating ideas and opportunities to alleviate the adverse by-products of our current unsustainable ways of living. Low emissions cars, more efficient mass transport systems, renewable energy investments, and water-savings technologies are just a few examples. The contention of this paper, however, is that STEM approaches to sustainable development are limited in confronting the speed and scale of the challenges we are now facing. While useful, they are limited, aimed more at problem-fixing – that is, reducing negative impacts - rather than imagining and creating dramatically new ways of conceiving and enacting sustainability. The world has known for at least thirty years that we need to integrate economic, social and environmental dimensions of development that requires more than a focus on scientific and technological fixes. Since the core of sustainability is the coupling of social and ecological systems, social scientists must be part of sustainable development conversations, seated at the table from the beginning when questions that require investigation are formulated, not appended onto the process after the questions have been posed (Bael, 2010).

3.1. The limits of STEM Education for Sustainable Development

The limitations of STEM as a contributor to sustainable development apply equally to STEM education for sustainable development. Despite calls in the 1970s for interdisciplinary approaches to environmental education – primarily the inclusion of the social sciences - scientific approaches to ESD continue to dominate, focused on building scientific and technological knowledge and skills as the main way to deal with, manage and alleviate the adverse by-products of unsustainable ways of living. What the social sciences add to ESD is recognition that sustainability is a human problem, not simply a scientific, engineering or technical problem. As noted earlier, the world has known for at least thirty years that we need to integrate economic, social and environmental dimensions of development. It is well past the time for this to become a widespread reality in how we educate for sustainable development.

Contemporary literature in ESD informs us that integrated, holistic approaches rather than narrow STEM approaches, offer the best opportunities for successful and widespread ESD because they encourage inclusivity and collaboration, and support ESD as 'everyone's business'. Further, these educational approaches recognise the pivotal idea that unsustainable development is derived from socially-produced behaviours, and hence require socially-derived solutions that depend on social critique and social practices that help citizens work together for the common good.

What this paper calls for is a rethinking of STEM education. It is no longer appropriate for science and technology education to be mainly about teaching and learning of science content, theories, laws and skills. STEM educators, too, must recognise that sustainability is fundamentally a human problem, not simply a science and technology problem. Educators from social science disciples and/ or science educators who are well versed in social education should be fully engaged in the design and delivery of educational approaches to help address sustainable development challenges. It is simply not enough to apply scientific ideas and technological applications when the issues of sustainably are complex, socially constructed, and require social action to deal with them. As Holbrook (2009) suggests "education for SD has little to do with accumulating a body of scientific knowledge and is far more aligned with the development of personal and social aptitudes leading to responsible citizenship" (p.44).

4. Activist, Collaborative Education for Sustainable Development

Recognition of the short comings of STEM for sustainable development demands transformative approaches to education (Mezirow, 2006) with characteristics including critical thinking and reflection; systems thinking; values and futures-oriented learning; and participatory, action-based, pedagogies where decision-making and action-taking in local contexts are favoured (Australian Government, 2009). A key content characteristic is recognition that healthy humans and healthy environments are interdependent (St. Ledger, 2005). This is not to say that STEM learning for sustainable development has no place. What I am stating is that it is not sufficient for dealing with our current circumstances.

4.1. What does ESD look like?

A focus on teaching and learning that engages learners directly with thinking about, and dealing, with their local environmental and sustainability issues is necessary, with learner participation and agency being central. New opportunities for learning become possible when learners are given the chance to engage with sustainability. Even preschoolers are capable of understanding and responding to sustainability issues, and can learn to participate and "make a difference" (Davis, 2010). This kind of action-oriented ESD means that scientific literacy needs to go beyond scientific problem-solving and to encompass socio-scientific decision-making aimed at creating an active, informed citizenry.

When applied in educational contexts, this kind of ESD supports pedagogies that encourage learners to critique current conditions and mindsets, propose solutions that promote sustainability, and importantly, take actions within their educational settings – their kindergarten, school, and university – and, ideally into the wider community. Such transformative educational approaches are required around the globe.

4.1. ESD in China

The foundation for developing a low-carbon, sustainable society in China lies in enhancing its environmental education system (Guo & Marinova, 2011). ESD is now a 'strategic theme' of China's educational reform and development, as articulated in the *National Outline for Medium and Long term Education Reform and Development (2010-2020)* (Ministry of Education of the Peoples' Republic of China, 2010). This document identifies sustainable development as an element of 'all-round development' within the National Plan and is discussed as a goal for a range of major educational projects and pilot reform programs. Another important policy document for China is its trial *Working Manual for Experiment on ESD* (China National Working Committee for UNESCO on ESD, 2011), that provides explanations, illustrations and strategies for ESD, expanding on the initiatives outlined in the National Plan. This new policy direction for China builds on earlier initiatives such as *Green Schools* that parallels Australia's *Sustainable Schools* initiative. Both movements are contributors to transformative, wholistic educational efforts that have gained traction in recent decades and have been championed across the globe by the *United Nations' Decade of Education for Sustainable Development* 2005-2014. China's Green School Project, an initiative of the Ministry of Education of China (MOE), has been funded by the State Environmental Protection Administration (SEPA). It commenced in 1996 and has been informed by the European *Eco-schools* movement that has been in operation since the 1970s. The program's key focus includes whole-school environmental management and protection, environmental education curriculum and professional development, and greening of school grounds. Schools comply with set criteria to receive government awards. Since the program's inception, tens of thousands of schools have received awards.

4.1. EFS in Australia

Education for sustainability (EfS), as it is called in Australia, has a history going back to the 1970s. Originally focused on schools, EfS embraces activities across all educational sectors and interests with a robust research community, as well as a strong practitioner focus. A thriving professional association with chapters in each state, annual national conferences, a research journal and regular electronic newsletters and bulletins, keeps the community active and engaged.

In the last decade, Australia signed up to *Sustainable Schools* which grew from earlier forms of environmental education in schools. The *Australia Sustainable Schools Initiative* (AuSSI) engages students, teachers and their communities in whole-school approaches to explore - through real-life learning experiences - improvements in a school's management of resources and facilities including energy, waste, water, biodiversity, landscape design, products and materials. Sustainable Schools also addresses associated social and financial issues within a school. Such activities are supported by a range of policies and plans at both state and national level, such as *Living sustainably: The Australian Government's National Action Plan for Education for Sustainability* (Australian Government, 2009). It is important to note, however, that Sustainable Schools – and indeed most EfS initiatives over the decades in Australia - has been supported through the federal Department of Environment, not the Department of Education. Unfortunately, at the

beginning of 2012 in a cost-cutting exercise, the Environment Department, withdrew funding support for AuSSI. Without pickup from state governments, there is likely to be limited ongoing support. The future of EfS in schools in Australia is less certain now than in the past.

5. Frontiers of ESD

Despite its fluctuating fortunes, internationally, it has been within primary and secondary schooling that ESD/EfS has had the longest history and the greatest impact. Now, I discuss two areas of education that have been much slower in taking up the challenges of sustainability. These are early childhood education and higher education, including teacher education.

5.1 Early Childhood Education

The early childhood education for sustainability (ECEfS) community is one of the newest and most active. Along with New Zealand and Sweden, Australia is an international leader in ECEfS. In Australasia, advocacy for ECEfS in kindergartens, childcare centres, preschools and other before-school educational settings has been led by a small number of pioneers and champions since the 1990s. The first international gathering for ECEfS - bringing together Australian and New Zealander advocates - was held in New Zealand only as recently as 2006 (Davis, 2010). Now, however, many early childhood services are looking at ways to adopt or adapt Sustainable Schools' principles to suit the contexts of early childhood education. Increasing pedagogical activity is also being invested in how to best enact EfS with preschoolers to support their development as eco-citizens, guided by the transformative approaches outlined earlier. Another area of engagement is how kindergartens and preschools can reduce their ecological footprint (Wackernagel & Rees, 1995) by reducing water, energy, and waste, for example, within their daily operations (McNicol, Davis, & O'Brien, 2011). Educational research in ECEfS is also beginning to emerge.

International interest in ECEfS has mirrored Australasian developments with an international coalition for ECEfS now taking shape. In 2007, Professor Pramling Samuelsson of Gothenburg University, Sweden, was appointed UNESCO Chair in Early Childhood Education and Sustainable Development. This led to the first global ECEfS gathering, which resulted in the first international report on ECEfS published by UNESCO (Pramling Samuellson & Koga, 2008). A second meeting in 2008 resulted in *The Gothenburg Recommendations on Education for Sustainable Development* which identified early childhood as a "natural starting point" for all ongoing education for sustainability (Centre for Environment and Sustainability, 2009). In 2010 and 2011, the first and second *Transnational Dialogues in Research in ECEfS* were held in Norway and Australia, respectively.

5.2 Universities and Teacher Education

At the university level internationally, *Green Campus* initiatives are also beginning to strengthen. While some universities have a long history of embedding sustainability into their management and pedagogical practices, many are only now beginning to see the importance of taking on such initiatives. In Australia, the *Australian Campuses for Sustainability* (ACTS) was formally established in 2006 to support such interest. Internationally, the *Talloires Declaration* (Association of University Leaders for a Sustainable Future,

1990) is being committed to, to assist universities to realise their role as educational leaders for sustainable development. In reality, though, for many universities, the focus remains on resource management such as reducing energy and power, building green buildings or retrofitting, rather than tackling the more difficult issue of 'greening' the curriculum.

There is another important element of higher education that is not yet pulling its weight for sustainability. This is teacher education where there has been growing recognition that teacher education institutions are not doing all they can to prepare teachers for teaching education for sustainability (Ferreira, Ryan, Davis, Cavanagh & Thomas, 2009). In Australia, the new National Curriculum proscribes sustainability as a cross-disciplinary strand for school education. As a consequence, this is providing impetus for teacher education institutions to examine their responsibilities for preparing the next generation of teachers to be more equipt to understand and implement EfS in classrooms. Such recent initiatives, nevertheless, are 20 years behind many schools in embedding sustainability into their courses. In practice, too, EfS within teacher education has been mostly ad hoc, dependent on the passion and persistence of individuals to initiate and maintain EfS within their teacher education courses. Systemic adoption of EfS into teacher education is in its infancy.

Nevertheless, times are changing. In Australia, some funding to support teacher education to transition to EfS is being supported through Education funding rather than as Environment initiatives. Networks of teacher education faculties engaging in such work are beginning to develop to assist teacher educators to learn about EfS and to begin to implement it within subjects and courses. A key plank of this work is emphasis on the interdisciplinary nature of sustainable development and ESD, so that academics from a wide range of discipline areas – not simply from STEM backgrounds - can learn the importance of embedding ESD into their areas of expertise. Hence, educators from the social sciences and the Arts, media and cultural studies, for example, are beginning to develop new and engaging ways to apply collaborative and activist approaches of EfS into their programs of study for preservice teachers.

6. Conclusion

Achieving education for sustainability as core business in education requires the interplay of formal and informal, individual and collective actions that generate change within all sectors of education. The role for teacher education is particularly important because the education of teachers is a pivotal plank for educating the next generations and their communities about and for sustainable living options. As teacher education addresses this task, it is important, however, that it embraces interdisciplinary, collaborative, and activist forms of ESD. This is a particular challenge for STEM education. Living sustainably is essentially a social issue. Hence, STEM education must engage with social processes and social education. Now is the time for STEM educators to rethink their approaches and to reach out to colleagues in the social sciences, arts, design and other education disciplines and professional communities. Now, too, there are opportunities for colleagues in countries such as Australia and China to look for ways to collaborate in ESD teaching and

learning initiatives, research projects, capacity-building programs, and other professional exchanges. Through new partnerships, new approaches, and new thinking, all of education can play constructive, transformative roles in creating green, just and healthy global futures.

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